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FINAL REPORT FOR Contract N00014-85-K-0631; R&T Code 4134003
EXCITED-STATE PROPERTIES OF SEMICONDUCTOR ELECTRODES AND THEIR
APPLICATION TO OPTICAL ENERGY CONVERSION

Arthur B. Ellis, PI

Over the past seven years we have examined the luminescent properties of a variety of n-type II-VI and III-V semiconductors. Photoluminescence (PL) from n-CdS, CdSe, Te-doped CdS (CdS:Te), and graded $\text{CdS}_x\text{Se}_{1-x}$, in particular, can be affected by applied potential, when the solids are used as photoelectrodes; and by adsorption of certain Lewis acids and bases onto the surfaces of the solids.

In a series of papers that are listed as part of this report, we have used the adsorption properties of these solids to create a new class of optically-coupled chemical sensors: since many of the adducts between surface atoms and molecules in the gas or solution phases are weak and reversible, the PL changes respond rapidly to concentration changes. Thus, the interactions serve as the basis for on-line chemical sensors. We have constructed a number of these devices using only a light source, optical fiber, the semiconductor sensor elements, and a light detector. Several patents, listed in this report, have been awarded for these structures.

In the course of these studies we have demonstrated that the PL effects result from adduct-modulated changes in the electric field thickness of the semiconductor: PL changes fit a dead-layer model, the premise of which is that electron-hole pairs formed within a distance on the order of the depletion width do not contribute to PL.

Time-resolved studies are consistent with this notion: for etched samples, PL decay curves are unaffected by adsorption. In contrast, PL from cleaved samples does not fit the dead-layer model and the decay curves are affected by adsorption, indicating that surface recombination velocity plays a more significant role in these systems.

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PUBLICATIONS, TECHNICAL REPORTS, AND PATENTS FROM Contract N00014-85-
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Arthur B. Ellis, PI

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"Chemical Sensing Applications of Semiconductor Photoluminescence," E.R.M. Luebker, L.K. Leung, C.J. Murphy, G.C. Lisensky, and A.B. Ellis, In *Biotechnology: Bridging Research and Applications*, D. Kamely, A. Chakrabarty, and S. Kornguth, Eds., Kluwer Pub.; Dordrecht, The Netherlands (1991).

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"Surface-Derivatized Semiconductors with Chemically Sensitive Luminescence", U.S. Patent 4,710,476 awarded 12/1/87 with A.B. Ellis and H. Van Ryswyk, inventors.

"A Luminescent Chemical Sensor for Gases", U.S. Patent 4,752,588 awarded 6/21/88 with A.B. Ellis, G.J. Meyer, and G.C. Lisensky as inventors.

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